the birds are very demonstrative, even theatrical and melodramatic at times. In some cases this is all right, in others it is all wrong. Birds differ in this respect as much as people do — some are very quiet and sedate, others pose and gesticulate like a Frenchman. It would not be easy to exaggerate, for instance, the flashings and evolutions of the redstart when it arrives in May, or the acting and posing of the catbird, or the gesticulations of the yellow-breasted chat, or the nervous and emphatic character of the large-billed water thrush, or the many pretty attitudes of the great Carolina wren; but to give the same dramatic character to the demure little song sparrow, or to the slow moving cuckoo, or to the pedestrian cowbird, or to the quiet Kentucky warbler, as Audubon has done, is to convey a wrong impression of these birds." The coloring, as, well as the posing, "is also often exaggerated." But in view of all that Audubon accomplished, and often under such adverse conditions, "it ill becomes us," says Mr. Burroughs, "to indulge in captious criticism."

In brief, Mr. Burroughs has well accomplished his task, and placed within the reach of the many persons interested in the personal history of the great pioneer painter-naturalist, in a handy and comparatively inexpensive volume, a concise history of his life, character, and works. The photogravure portrait serving as frontispiece is from the well-known painting by Healy, made in 1838, now owned by the Boston Society of Natural History. — J. A. A.

Strong on the Development of Color in Feathers. — In a paper[1] of 40 pages, illustrated with 9 plates, Dr. Strong gives a detailed account of his investigations of the development of color in feathers. The work was done in the Zoölogical Laboratory of Harvard University, under the direction of Dr. E. L. Mark. It was begun in the fall of 1899, and was continued at intervals for many months, the material used being principally the remiges of the Common Tern (*Sterna hirundo*), but feather germs were also used from "*Passerina ciris* Linn., *Passerina cyanea* Linn., *Munia atricapilla* Hume, and the common dove," and dry feathers from *Cyanocitta cristata*, *Sialia sialis*, *Pitta sordida*, *Pitta moluccensis*, *Cotinga cayana*, and *Megascops asio*. Dr. Strong was well qualified for the task by his special training in the requisite technique of such investigations, and enjoyed the exceptional advantages of a well equipped laboratory, famous for its facilities for histological investigation. The paper is necessarily highly technical, and the results and not the methods will here receive notice.

A brief introduction is followed by 'II. Methods and Materials'; 'III. The Development of the Feather,' considered under 'A. The Feather

[1] The Development of Color in the Definitive Feather. By R. M. Strong. Bulletin Mus. Comp. Zoöl., Vol. XL, No. 3, pp. 146–186, pll. i–ix, October, 1902.

Germ'; 'B. The Differentiation of the Feather,' as (1) the barbules, (2) the barbicels, (3) the barb, (4) the rhachis, (5) the residual cells, (6) the cornification and withdrawal of the feather. 'IV. The Production of Color in the Feather'; 'V. The Pigmentation of the Feather'; under which are considered, (A) the chemical nature of feather pigments, (B) the origin of pigment, and (C) the distribution of pigment in feathers. 'VI. Change of Color without Molt'; 'VII. Summary'; and 'Bibliography.'

In his introduction the author says: "A theory of change of color without molt was the subject of a rather warm controversy about the middle of the nineteenth century, and there has been something of a revival of the discussion in the last few years. It has seemed to me that a solution of the problem could not be attained without a thorough consideration of the causes of color and its development."

Under 'VI. Change of Color without Molt,' he states: "The changes in color claimed by many writers to occur without molt may be grouped under two heads: (1) the destructive, and (2) the constructive. Under destructive changes are included the results of abrasion and physical disintegration. Constructive changes include supposed regeneration and rearrangement of pigment." Then follows a reference to the recent writers on the subject, who have claimed change of color without molt, of which he says: "Descriptions of repigmentation have been mostly pure speculation. Within a few years the following remarkable explanation of the pigmentation of the feather has been given by Keeler ('93)": which he then quotes. He cites the still more recent work of Birtwell, from whom he quotes concerning the supposed rearrangement of the melanin granules in the feathers of the Indigo Bunting; and also quotes Chadbourne's argument for a so-called vital connection of the feather with the organism. After noting the claims of these and other authors, and explaining to some extent the sources of their errors, he says: "There is no satisfactory evidence of the occurrence of repigmentation . . . .

"Pigmentation takes place, as has been shown, at a very early stage in the differentiation of the feather, when the cells composing its fundament are in an active condition and in intimate relation with sources of nutrition. In the case of melanin pigments, there are branched pigment cells which supply pigment in the form of rod-shaped granules directly to the feather fundament. The contention for a flow of pigment from the barbs into the barbules, etc. (Keeler), is at once made absurd by the fact *that the barbules are pigmented before the barbs are differentiated.*[1]

"Variations in color patterns are usually correlated with variations in the distribution of pigment in the earlier stages of the feather's development. When completed, the feather is composed of cells which have been entirely metamorphosed into a firm horny substance and its pigment is imbedded in that lifeless matter. The cells composing a barbule are fused into a solid, more or less homogeneous structure. *The pigment of one portion of the barbule is as effectually isolated from that of another as*

[1] Not italicized in the original.

is the coloring of various parts of a piece of agate.[1] Likewise in the barb and rhachis, pigment is definitely and permanently located either in the solid cortex or in effectually separated cells of the medulla; and there are no pores large enough to admit the passage of melanin granules. The characteristic longitudinal arrangement of melanin granules, which one finds at the close of cornification of the feather, is permanent. . . .

"When the feather is completed, the dermal pulp possesses no functional connection with it; the barbs and barbules are then practically isolated from the vital processes of the organism and have no further power of growth.

"The arguments against change of color without molt through repigmentation or regeneration may be summed up as follows:

"1. Most feather pigments are too resistant to chemical reagents to warrant belief in their solution and redistribution.

"2. Pigmentation of the feather has been observed to take place only in the younger stages of the feather germ.

"3. At the end of cornification melanin granules have a definite arrangement, which is permanent.

"4. When cornification has ensued, the various elements of the feather are hard, more or less solid, structures and their pigment contents are effectually isolated from one another.

"5. There is no satisfactory evidence of the occurrence of repigmentation, and all the histological conditions render such an event highly improbable."

The results of his histological studies on the formation and growth of the feather, the differentiation of the various parts of its structure, the origin and supply of pigment to the feather, etc., are summarized in sixteen numbered paragraphs at the close of the paper, from which we quote the following:

"15. Before cornification has ceased, all the pigment which the feather is ever to receive has been supplied to the cells composing its fundament [the growing base of the feather].

"16. Changes in the color of plumage may take place (1) by a molt, during which the new feathers may have the same pigmentation as their predecessors or a different one; (2) by a loss of certain portions of the feather; or (3) by physical disintegration in the cortex of the feather as the result of exposure. There is no satisfactory evidence of a process of repigmentation, and the histological conditions of the feather render such a process highly improbable."

Dr. Strong's paper is one of the most noteworthy ornithological papers of the year, and should go far toward the settlement of the much discussed question of the repigmentation of feathers. We have here the results of an impartial investigation by an expert histologist, in opposition to speculation and conjecture, put forth by persons untrained in modern histological methods.—J. A. A.

[1] Not italicized in the original.